Do Banks Hedge in Response to the Financial Distress Costs?

Amiyatosh Purnanandam*
University of Michigan Business School
Ann Arbor, MI – 48109
Email: amiyatos@umich.edu

First Draft: November 2002
This Draft: September 2004

(Comments Welcome)

* This paper is based on a chapter of my doctoral dissertation at Cornell University. I would like to thank Warren Bailey, Rosalind Bennett, Murillo Campello, Dennis Capozza, Sudheer Chava, Serdar Dinc, Yaniv Grinstein, Bob Jarrow, Ed Kane, Han Kim, Anil Kumar, Haitao Li, Bernadette Minton, Patrick Morris, Uday Rajan, Jayanthi Sunder and Bhaskaran Swaminathan for their helpful comments. I am indebted to N.K.Chidambaran, Robert Hauswald and Haluk Unal for their discussant reports and Mark Flannery for sharing useful data with me for this study. I also thank seminar participants at Cornell University, FDIC, University of Michigan and Western Finance Association's meeting at Los Cabos. Financial support from FDIC's Center for Financial Research is gratefully acknowledged. All remaining errors are mine.

Abstract

I analyze the effects of firm characteristics, managerial incentives and macroeconomic shocks on the interest rate risk-management behavior (both by means of derivatives and non-derivatives techniques) of commercial banks. Using historical bank-failure data, I construct an explicit instrument for the bank's 'distress likelihood' and find evidence in support of the risk-management theories based on the cost of financial distress (Diamond (1984), Smith and Stulz (1985)). I find that banks use off-balance sheet hedging strategies (i.e., risk-management with derivatives) as a substitute for their on-balance sheet strategies (i.e., the management of maturity GAP). The effects of macroeconomic shocks (tightness of monetary policy, volatility of interest rates, term-spread and credit-spread) are more pronounced on the on-balance hedging decisions. In a tight monetary regime banks significantly lower their asset-liability mismatch at the balance sheet level. However, this effect is limited to the derivative non-user banks only. My findings suggest that a potential benefit of derivatives usage is to minimize the effect of external shocks on a firm's operating policies.

Banks act as financial intermediaries and generate economic rents for their services such as credit evaluation, monitoring and debt-collection. Financial intermediation often exposes them to interest rate risks by creating mismatches in the maturity structure and re-pricing terms of their assets and liabilities.[1] Banks use various tools including the use of interest rate derivatives to manage these risks (e.g., see the case study of Banc One Corporation by Esty, Tufano and Headley (1994)). In the presence of costly bank failures, Diamond (1984) argues that banks should hedge all systematic risks (such as the interest rate risks) in which they don't have any special monitoring advantages. For non-banking firms, Smith and Stulz (1985) show that the hedging of interest rate risk can increase firm value by lowering the expected transactions cost of bankruptcy. Other motivations for managing risks include managerial risk aversion, costly external financing, information asymmetry between the insiders and outsiders of the firm and convexity of taxes (see Stulz (1984), Smith and Stulz (1985), DeMarzo and Duffie (1991) and Froot, Scharfstein and Stein (1993)).

In this paper, I analyze the determinants of a bank's interest rate risk-management decisions both by means of on-balance sheet techniques (i.e., by matching the GAP in the maturity and re-pricing terms of their assets and liabilities) and off-balance sheet instruments (i.e., by using interest rate derivatives).[2] While the role of maturity GAP and derivatives activities on a financial institution's stock returns has been studied well in the literature (e.g., Flannery and James (1984b) and Schrand (1997)), the goal of this paper is to understand how various firm characteristics, macroeconomic variables and managerial incentives influence these decisions in commercial banks. I use a panel data of about 8000 banks over 25 quarters during 1997-2003 to investigate these issues in this paper. A large body of research investigates the determinants of the hedging activities of a firm.[3]

[1] Flannery and James (1984b) provide evidence on the economic importance of these mismatches by analyzing the relation between the interest rate sensitivity of common stock returns and maturity composition of the bank's assets and liabilities.

[2] All analyses in this paper are based on derivatives used for 'hedging purposes' only.

[3] See Nance, Smith and Smithson (1993), Dolde (1993), Mian (1996), Tufano (1996), Geczy, Minton and Schrand (1997), Graham and Smith (1999), Haushalter (2000), Knoff, Nam and Thornton (2002) and Graham and Rogers (2002) among others for evidence on non-financial firms. For studies related to financial firms see Booth, Smith and Stolz (1984), Schrand and Unal (1998) and Carter and Sinkey (1998). See Gorton and Rosen (1995) for an analysis of the effect of interest rate swaps on the systemic risk in banks.

My study differs from the existing literature on several dimensions and makes four key contributions to the literature.

First, the panel data allows me to draw new cross-sectional and time-series inferences. Most importantly, I investigate the effect of macroeconomic shocks on the risk-management decisions of the banks. Since the existing studies have focused on the firm characteristics and managerial incentives to explain the firm's hedging behavior, the role of external macroeconomic shocks on a firm's hedging behavior is less understood. I provide new evidence on the role played by tightness of money supply, volatility of interest rates and the levels of term-spread and credit-spread on hedging decisions and suggest a novel potential benefit of derivatives usage - the derivative instruments make the bank's operating policies less sensitive to the macroeconomic shocks. To the extent a smooth operating policy is desirable, derivatives can add value to a firm by insulating its operating policies from the external shocks.[4] This evidence can potentially reconcile the findings of Allayannis and Weston (2001) who find a significant effect of derivatives on firm valuation and Guay and Kothari (2002) who find that derivative instruments can generate only a modest level of cash-flows in the bad states of the world.

The second contribution of the paper is to use a direct measure of financial distress cost to test the risk-management theories. Unlike previous studies that use leverage and interest coverage ratios as proxies for financial distress, I use the historical bank failure data to model a bank's failure likelihood and its risk-management decisions as two endogenous variables. Using a two stage estimation methodology, I construct an instrument for distress likelihood and use this measure to provide direct evidence on how distress likelihood affects the level of maturity GAP and derivatives position of the banks.[5]

[4] This is consistent with Minton and Schrand (1999) who show that the cash-flow volatility is costly as it affects a firm's investment policy by increasing both the likelihood and the cost of raising capital.

[5] First I take the failure likelihood as a proxy for the cost of financial distress, which assumes that the losses in the event of default are same across the sample banks. Subsequently, I repeat my analysis by modeling the 'loss given default' and 'risk-management' decisions as endogenous. My results remain similar for these alternative specifications of financial distress proxies.

Third, unlike most of the previous studies that take the use of derivatives as a proxy for financial risk-management, I consider both the derivatives-hedging and non-derivatives hedging (i.e., maturity GAP decision) decisions simultaneously. As shown by Petersen and Thiagarajan (2000), firms with different (similar) derivatives strategy can still have very similar (different) risk-management strategy after considering their non-derivatives positions. Thus it becomes important for empirical studies to consider a broader measure of hedging that includes both these aspects of a firm's risk-management behavior. My measure of hedging achieves this goal as it covers both the asset-liability mismatch decision and the extent of derivatives used by the banks. I analyze the simultaneous choice of these alternative means of managing interest-rate risk and provide new evidence on whether these methods act as complements or substitutes. Further, the study allows me to assess the impact of hedging motivations on these measures separately.

Finally, my study provides evidence from a large panel of firms as against small samples studies, based on hand-collected or survey data, employed by the earlier papers. Thus my study is free from the small sample or survey response biases. Further, my data allows me to control for the maturity structure of derivative instruments and thus provides a more refined measure of the hedging activities.

My sample is particularly well suited for analyzing the theories of interest rate risk management. First, banks face a high degree of interest rate risks and therefore these decisions have a first-order impact on their performance. Secondly, banks are highly leveraged and face significant transactions cost of bankruptcy. James (1991) show that the direct losses of bank failures such as administrative and legal expenses are about 10% of the total assets. Finally, this sample provides a unique setting to analyze the effect of exogenous macroeconomic shocks on hedging decisions. These shocks affect the entire banking system and I am able to analyze why banks respond to them differently. Since these shocks are exogenous, the cause-effect relation is unambiguous in my study.

Consistent with the results of earlier work, first I find that the economies of scale play an important role in the derivatives usage.[6] As predicted by the theories of Diamond (1984) and Smith and Stulz (1985), I find that the financial distress costs play an important role in the banks' hedging decisions. Banks facing higher likelihood of financial distress manage their interest rate risks more - both by maintaining lower maturity GAPs and by engaging in higher derivatives activities. As noted in the case study of Banc One by Esty, Tufano and Headley (1994), I find that the derivative instruments act as substitutes for on-balance sheet risk-management. In a simultaneous equation framework, banks with lower (higher) maturity GAP use less (more) interest rate derivatives and vice versa. Consistent with the predictions of Froot et al. (1993), I find that the high growth banks engage in higher hedging activities.

While firm level characteristics affect the maturity GAP and derivatives hedging decisions in qualitatively similar ways, I find that the macroeconomic shocks have more pronounced effect on the on-balance sheet hedging activities and only a moderate effect on derivatives usage. In a tight money supply regime (proxied by higher level of interest rates) and in a higher term-spread economy (i.e., larger difference between 10 year and 1 year treasury yields), banks maintain lower mismatch in their assets and liabilities. Thus, when liquidity is more valuable and the difference between the short term and long term rates higher, banks tend to avoid interest rate risks. These findings are consistent with both the 'distress cost' and 'costly external financing' based views of hedging.

Next I analyze the maturity GAP decisions of the derivative users and non-users separately. My results indicate that the derivative non-users respond very aggressively to these shocks. They significantly decrease their maturity GAP in tight monetary regime and higher term-spread economy. On the other hand, the derivative users respond to these shocks in an insignificant manner. Firm level variables affect the maturity GAP decisions of both groups in similar ways. This finding suggests that by using derivatives, banks are able to 'insulate' their maturity GAP policy from the external shocks. This is a novel

[6] In line with the earlier empirical work in the banking literature, I analyze small and large banks (banks with less or more than $100 million in assets) separately. I also analyze these groups together and the key results remain qualitatively similar as discussed later in the paper.

incentive of derivatives usage which has not been explored much in the literature. Derivatives usage allows banks to make only minor (or no) adjustments to their operating policies (such as making loans and investing in securities) in the event of macroeconomic shocks. Making adjustments to the operating policies can be costly if banks need to offer different terms to their relationship borrowers or depositors to achieve such adjustments. By allowing a bank to maintain its core business under changing macroeconomic environment, derivatives can add value to the shareholders.

For a smaller sub-sample of banks with data on managerial compensation, I find that firms with higher managerial 'vega' maintain higher maturity GAP and engage in less derivative activities.[7] This is consistent with the view that when managers have higher incentive to engage in risk-seeking behavior they manage less risk (see Stulz (1984) and Tufano (1996)). However, I don't find evidence in support of a positive relation between managerial 'delta' and hedging activities as predicted by the theories of hedging based on managerial risk-aversion.

The plan for the rest of the paper is as follows. In section I, I discuss the research design and explain the key hypotheses. Section II provides the data description and construction of hedging variables. In Section III, I provide the main empirical findings. Section IV provides some robustness results and Section V concludes the paper.

I. Research Design

Diamond (1984) develops a theory of financial intermediation in which banks have monitoring advantages as compared to small depositors. But they also suffer from incentive problems due to the delegated monitoring on behalf of their depositors. He shows that diversification within a bank lowers the cost of delegated monitoring and generates net benefits of intermediation services. An implication of his model is that

[7] For this sub-sample the bank must be covered by the COMPUSTAT executive compensation database, which limits my analysis to a very few banks. To measure the managerial incentives, I compute 'delta' and 'vega' of the stock and option holdings of the top 5 managers of the firm using the method suggested by Core and Guay (1999). 'Delta' measures the sensitivity of their wealth to changes in firm's stock prices, whereas 'vega' measures the sensitivity with respect to the return volatility of the stock.

banks should not assume any risks that are not diversifiable unless they have special advantages in monitoring them. Thus in his model, banks find it optimal to hedge all interest rate risk either by using derivatives contract or by matching the maturity of assets and liabilities. The incentive to hedge interest rate risk increases with the cost of bank failure since assuming these risks increases the likelihood of bank failure without providing any incentive benefits to the banks as delegated monitors. In the context of non-financial firms, Smith and Stulz (1985) show that hedging can increase firm value by reducing the variability of the firm's cash-flows, which in turn lowers the expected cost of bankruptcies (see also Mayers and Smith (1982)). Another benefit of hedging comes by way of increased debt-capacity of the firm as argued by Stulz (1996) and Leland (1998).[8]

Froot et al. (1993) develop a model in which they endogenize the distress costs. In their model, external funds are costlier than the firm's internally generated cash. If a firm experiences negative shock to its cash flow, it would be forced to raise funds from external market (and thus incur the deadweight costs) to meet its investment needs. Firms may have to forego positive NPV projects in some bad states (low internal cash-flow) of the world. Hedging strategies add value to the firm by removing these inefficiencies.

In line with these theoretical models, I hypothesize that the risk-management incentive of a bank is an increasing function of its expected financial distress costs. A firm should hedge more if it has higher expected costs of bankruptcies. At the same time a firm's likelihood of default (and therefore expected cost of bankruptcy) will come down if it hedges more. I model both the bank's hedging decision and its failure probability as endogenous variables in the model. Using a two stage estimation technique I estimate the following model using each bank-quarter as a separate observation:

[8] If banks receive subsidized deposit insurance from the FDIC, it may lead to a moral hazard problem (see Buser, Chen and Kane (1981)) by providing excessive risk-taking incentives to the owners of the banks. However regulatory (such as FDIC inspection) and market discipline can help minimize this problem to a large extent. Since, banks also raise funds from other sources, the extent of risk-seeking behavior would be further limited. Purnanandam (2004) analyzes the issue of 'hedging' vs. 'risk-shifting' incentives for non-financial firms and shows that such risk-shifting incentives dominate the risk-management incentives of only those firms that are very close to financial distress.

$$P(D=1)=f(X_1,H)$$
$$H=g(X_2,D)$$

D is a binary variable that equals one if bank fails and zero otherwise. H refers to the hedging decision both by means of 'derivatives' and 'maturity GAP management'. X_1 and X_2 are the other variables that affect a bank's default likelihood and hedging decisions respectively. These variables are chosen based on the existing theoretical models and empirical findings and are discussed below.

There is a large literature in finance and accounting studying the corporate bankruptcies (see Altman (1968), Ohlson (1998), Shumway (2001) and Chava and Jarrow (2004)). In line with these studies and the popular CAMEL rating of the regulators such as FDIC, I model the bank's failure probability as a function of its size (log of total assets), deposits (total deposits / total assets), non-deposit liabilities scaled by the total assets, profitability (net income / total assets), asset-mix (percentage of loans and leases in the total assets of the bank) and non-performing asset (NPA/ total assets). [9] Duffie, Jarrow, Purnanandam and Yang (2002) use a similar model to estimate the failure probability of banks which are used for the market pricing of FDIC deposit insurance.

For the risk-management decisions, I use the bank's size as a control for the economies of scale in derivatives usage (see Dolde (1993)). In line with Froot et al. (1993), I include the average quarterly growth rate of a bank (measured as percentage growth in assets over the past four quarters) as a proxy for its need to access external capital markets. Froot et al. predict that high growth banks should have higher hedging motivations to avoid the cost of external funding. I also include the level of liquid assets as a control variable since liquid assets can act as a substitute for the hedging activities. To capture the effect of insured deposit financing, I include a bank's deposit ratio in the hedging

[9] I also experiment with additional and alternative variables such as the asset-liability ratios, percentage of real estate backed loans in the total assets, provision for bad loans as a percentage of total assets, percentage of interest income in total income of the bank, capital ratios and deposit-equity ratio. The results don't change qualitatively.

model. Banks that rely more on deposit financing may have less incentive to hedge due to the insurance provided by FDIC. Alternatively, these banks have perhaps limited access to external capital markets and thus face more binding capital constraints as compared to the other banks. Thus, this effect should induce them to hedge more in line with the predictions of Froot et al.

Finally, for a subset of banks that are covered on the COMPUSTAT executive compensation database, I control for the managerial incentives by computing the 'Delta' and 'Vega' of the top 5 managers of the bank. While 'Delta' captures the sensitivity of managerial wealth to stock prices, 'Vega' measures its sensitivity with respect to the stock return volatility. These measures are computed using the method suggested by Core and Guay (1999). In line with the predictions of Stulz (1984), risk-management incentives should be positively related to 'Delta', but negatively related to 'Vega' of managerial shares and options holdings.

In addition to the firm level variables described above, I use four macroeconomic variables in the hedging model. First, I control for the level of interest rate (measured by annualized yield on 3-months treasury rates during the quarter) in the economy as a proxy for the tightness of money supply.[10] The cost of cash-shortfall is higher in such a scenario and therefore the hedging strategy may add value under such regime. I include the volatility of interest rates (measured as the standard deviation of 3-month T-Bill yield during the quarter) as the second macroeconomic variable. Higher interest rate volatility increases the variance of firm's cash-flows and thus induces higher risk-management incentives all else remaining equal. Next I add the term-spread and credit-spread variables in the model. Term-spread is defined as the yield difference between 10 and 1 year treasuries. When term-spread is high, funding long (short) term assets with short (long) term borrowings can be costly leading to higher hedging incentives. Finally, the credit-spread (measured as yield difference between the BAA and AAA corporate debt)

[10] Bernanke and Blinder (1992) show that the federal funds rate capture the stance of the monetary policy well. This is the prevalent measure of monetary policy used in the empirical work. I use the market based yield on 3-month T-Bills as a proxy for the monetary policy. The correlation between 3-month T-Bills rate and Fed Funds rate is over 98%.

captures the effect of overall credit quality in the economy. It allows me to analyze if the economy-wide credit quality (in addition to firms own default risk) has any impact on the hedging decisions of banks or not.

In the first stage of estimation, I use a discrete time hazard rate model with bank failure as the event and all exogenous variables as explanatory variables. Shumway (2001) shows that the discrete-time hazard rate can be modeled as a logit model with each bank-quarter as separate observation. This estimation technique results in unbiased estimates of the default probabilities and it makes full use of the historical information (see Shumway (2001) for a detailed discussion of this approach).

I use the estimated probability of default (called PD) from the first stage estimation as an instrument for financial distress costs in the second stage risk-management equation. There are two ways in which a bank can manage its interest rate risks: (a) by matching the maturity and re-pricing terms of its assets and liabilities and (b) by engaging in derivatives transactions. First I consider these two methods of hedging as independent decisions and analyze the determinants of these choices separately. Next I treat them as simultaneous choices and model them together. My econometric analysis uses both a Fama-McBeth type cross-sectional analysis and a panel regression with fixed effect for every bank. I discuss the econometric issues in more detail later in the paper.

II. Data and Construction of Hedging Variables

A. Data Sources

There are two main sources of data in this study - (a) Call Report data obtained from Federal Reserve Bank that contains quarterly accounting information for every insured commercial banks in the U.S. and (b) the historical bank failure data from FDIC. These data sources are supplemented with COMPUSTAT executive compensation database and macroeconomic data obtained from the Federal Reserve Bank. FDIC's bank failure data covers all ‘bank failures’ and ‘open bank assistances (OBA)’ during the period 1980-2003.[11]

For the estimation of hazard rate model, I include all insured commercial banks with non-missing observations on total assets, total loans and equity at the end of the each quarter during 1980-2003 in my sample. In line with the earlier literature (see Campello (2002)), I exclude bank-quarter observations with more than 50% growth in assets. I also require information on all covariates (i.e. X_1 and X_2 in the default and hedging model) to be available for a bank-quarter observation to be included in the sample. This leaves me with a sample of 853,469 bank-quarter observations and 1,443 bank-failures over 1980-2003 that are used to fit the hazard rate model. Since the relevant items to compute ‘maturity GAP’ and ‘derivatives used for hedging purposes’ are only available from the third quarter of 1997, the second stage hedging models are estimated using 25 quarters of observations from 1997Q3 to 2003Q3.

Due to the changing reporting requirements, some of the call report items are not comparable across reporting quarters. I follow Kashyap and Stein (2000) and Campello (2002) to form consistent time-series from these items. For the variables that are not covered in these studies (such as the maturity GAP and derivatives), I form consistent time-series by analyzing the call report forms. A detailed description of the various call report data items that are used to form the consistent time-series of these variables are provided in the Appendix.

B. Construction of Hedging Variables

Hedging by means of Derivatives: I obtain the data on derivatives from the Schedule RC-L of the quarterly Call Reports and support it by sources such as 10-K filings. Commercial banks report their usage of derivatives for trading and non-trading purposes

[11] In the case of failure FDIC steps in and closes the operations of the bank, whereas in OBAs banks are allowed to continue to operate with some re-structuring or help from FDIC. OBAs have become very uncommon in the recent years. During the sample period OBAs accounted for 6% of total bank distress events.

separately starting from the first quarter of 1995. Banks engage in derivative contracts both as an intermediary and as end-users. As an intermediary, the role of derivatives is for business purposes and not for hedging. In the Call Report, banks report contracts used in the course of dealing and other trading businesses as ‘contract held for trading purposes’.[12] The derivative instruments used for hedging purposes are reported as ‘contract held for non-trading’ purposes. I take the notional amount of derivatives reported under the non-trading purposes and scale it by the total assets of the bank at the end of each quarter. I take the log of this ratio to construct the derivatives-hedging measure. I confirm these numbers with the annual financial statements of a random sample of 70 banks to ensure that these derivatives are indeed used for risk-management purposes. Further, as noted in the derivatives report of OCC (the Office of the Comptroller of Currency) the trading activities are mostly concentrated in top 25 banks; the remaining banks use derivatives mostly for risk-management purposes only.[13] In one of the robustness tests, I exclude top 25 banks from the analysis to show that my results are not driven by the presence of these banks in the sample.

Hedging by means of non-derivative techniques: I construct a measure of the bank’s asset-liability maturity mismatch as a proxy for the on-balance sheet risk-management activities. Lower maturity mismatch corresponds to higher risk-management activities. To construct this measure I follow the approach of Flannery and James (1984 a, b) and construct a 12-month GAP measure. This measure captures the net imbalances in the effective maturity (i.e. adjusted for re-pricing terms) of the asset and liabilities of a bank over the 1-year period. Starting third quarter of 1997, banks provide a detailed account of their assets and liabilities that are due to mature or re-price within a year. My measure is similar to the SHORT measure used by Flannery and James and is defined as the absolute value of (asset that mature or re-price within a year minus liabilities that mature or re-price within a year) scaled by the total assets of the bank. The exact construction of this variable is provided in the Appendix.

---

[12] Any derivative instrument bought as a hedge for these trading assets are also treated under ‘contracts held for trading purposes’.

[13] See http://www.occ.ustreas.gov/ftp/deriv/dq202.pdf for details

Since demand deposits do not have any stated maturity, there are two approaches to incorporate them into the GAP variable. One view, consistent with the findings of Flannery and James, is to consider them as core deposits and therefore treat them as long term liabilities.[14] I adopt this view in the base case analysis. An alternative view is that demand deposits are subject to withdrawal at any time and therefore a part of it must be considered as short term liability. In one of the robustness tests, I consider 50% of the demand deposits as short term liability and re-estimate my models. The key findings remain qualitatively unchanged for the alternative definition of GAP.

C. Descriptive Statistics

Table 1 provides summary statistics of the interest rate derivatives used for risk-management purposes by the commercial banks over 1997-2003. Out of over 8000 commercial banks, on average only 385 banks use interest rate derivatives for hedging purposes. As of the end of fourth quarter of 2003, the gross notional amount of interest rate derivatives amounted to about $2.4 trillion. As seen from this table, interest rate derivatives are the most widely used tool of risk-management by the banks representing about 90% of the total derivatives (including foreign currency, equity and commodity) used by banks for the hedging purposes. The table also presents the total amount of derivatives used for risk-management purposes as reported by the OCC. As can be seen, the aggregate amount as shown by my dataset is very close to the numbers reported by OCC.

In table 2, I provide the distribution of derivative users across various size categories. I find that about 85% of the derivative hedgers belong to the top quintile of size distribution. There are practically no users of derivatives in the bottom 40% of the banks. As shown in Panel B, historically more banks have failed in the smaller size categories. The smallest size category accounts for about 33% of bank failures as compared to about 15% for the biggest banks. A large number of smaller banks fail, but only a very few of them engage in derivatives-hedging activities. This analysis points to a possibility of

[14] A similar view is presented in the case study of Banc One by Esty et al. (1994).

economies of scale in derivatives usage. Perhaps smaller banks do not have the necessary skill to use derivatives (see Dolde (1993)) or perhaps they manage their maturity GAP more conservatively and avoid the usage of derivatives in the first place. I analyze these possibilities in a multivariate setting later in the paper.

Table 3 provides the operating characteristics of the users and non-users of interest rate derivatives based on a sample of 213,874 bank-quarter observations for the period 1997-2003. There are 9,648 observations for the users of interest rate derivatives and the remaining for the non-users. The user banks are significantly bigger than the non-users. As expected, both users and non-users rely on deposit financing as their main source of funding; however non-users have higher percentage of deposit financing than users. To the extent that bigger banks have easier access to other sources of financing, it is not surprising that users, who are typically bigger banks, have relatively lower reliance on the deposit financing. The derivative users keep relatively lower amount of liquid assets as compared to the non-users. Consistent with the findings of Schrand and Unal (1998) and Brewer, Minton and Moser (1998), I find that the derivative users make more 'Commercial and Industrial Loans' than the non-users. Finally, users maintain higher maturity GAP than the non-users.

III. Empirical Results

A. First Stage Estimation of the Distress Likelihood

The parameter estimates from the first stage distress likelihood model, estimated using a logistic regression, are provided in Table 4. I provide estimation results from three models: first by pooling all banks into one group and then by separating small and large banks into two different groups depending on whether their asset value in 2003 dollar terms is below or above $ 100 million. In line with the banking literature I conduct my analysis separately for these two groups of banks. The pooled model uses 853,469 bank-quarter observations with 1,443 failures over 1980-2003. The small bank sub-sample is estimated using 513,836 bank-quarter observations and 1,064 failures whereas the large bank sample is estimated using 339,633 bank-quarter observations and 379 failures.[15]

The parameter estimates are qualitatively similar across the two groups of banks. I find that the distress probability is negatively correlated with the size - smaller banks are more likely to experience distress than the bigger banks. Banks with higher deposits as well as non-deposit liabilities are more likely to experience financial distress. As expected, banks with higher non-performing assets (NPA) are more likely to experience distress. Higher liquidity, larger percentage of loans in total assets and higher growth in total assets are negatively correlated with the distress likelihood. Bank failure is positively correlated with the level of interest rates and term-spread. Perhaps a little surprisingly, few banks fail in a more volatile interest rate regime. The model has robust goodness of fit properties as reflected by the high values of 'percent concordant' and 'Gamma' statistics. These statistics measure the power of the model to predict the dependent variable based on the values of the independent variables. Since I use the model implied default likelihood as key explanatory variable in my empirical analysis, it is important that the default model captures the cross-sectional and time-series variations in the banks' expected distress costs well.

I conduct out-of sample tests to assess the predictive power of my model. The results are presented in Table 5. A good model of distress prediction should possess two properties: (a) In a cross-section of banks it should be able to discriminate between good and bad banks and (b) In a time-series, it should be able to separate periods of high distress from those of moderate and low distress. My model does a reasonable job on both of these dimensions. Starting from 1990, I estimate the model parameters with strictly ex-ante data and then compare the model predicted failure probability against the actual failures in the next year. For example, for year 1992 I take all bank failures till the end of year 1991 and estimate the model. With these parameter estimates and the accounting data from the last quarter of the 1991, I obtain the predicted default likelihood for all surviving

[15] As robustness, I also consider an alternative specification that fits the distress model using failure data up to 1997 only. Results from this model remain qualitatively similar to the case presented in the paper.

banks. I sort the surviving banks into deciles based on the predicted default likelihood and provide a distribution of banks that actually failed during the year (i.e. during 1992 in this example), across these deciles. For this table, I only provide results based on 'all bank model' since other models produce similar results.

About 90% of the banks that fail during the year belong to the top decile of failure probability as of the beginning of the year. This is an encouraging result as it tells us that the model is able to differentiate between banks that are likely to experience distress from those that are not. In Table 5, I also report the model estimated annual failure rates of all banks in the sample and the banks that eventually failed during the year. As expected, the median failure likelihood is much higher for the banks that eventually failed than the median for the entire sample. The average annual predicted failure rate for the entire sample of banks over 1990-2003 works out to about 0.12% as against about 7.5% for the failed banks. The failure probability of the aggregate sample corresponds to the historical failure rate of a BBB+ rating of Standard & Poors and Baa2 of Moody's. The model predicts higher default likelihood (about 0.27% per annum) for the early nineties and a much lower likelihood for the later years. This is consistent with the actual failures and overall health of banking industry over this time-period.

B. Cross-Sectional Regression Results

My first analysis uses a Fama-McBeth approach to estimate the effect of firm level characteristics on maturity-GAP and derivatives-hedging decisions. In Panel A of table 6, I present the results for maturity-GAP decision for three models: 'All Banks', 'Small Banks' and 'Large Banks'. For every quarterly observation, first I estimate a cross-sectional OLS regression with maturity GAP as dependent variable and then report the time-series means of the parameter estimates and their corresponding p-values. The p-values are computed using Newey-West heteroskedasticity- and autocorrelation-consistent errors. I use the log of predicted default likelihood (PD), obtained from the first stage regression, as independent variable in the paper.

I find a negative and significant coefficient on the probability of default variable (PD) for all three models. Firms with higher default likelihood maintain lower mismatch in their assets and liabilities i.e., they hedge their interest rate risk more. Moreover, this relationship is stronger for the small banks group. For a given increase in default likelihood, small banks are likely to reduce their maturity GAP by 50% more than the large banks. For all three models, the parameter estimates are stable across quarters. On a quarterly basis, the coefficient on PD variable is negative and significant (at 1%) for 24 out of 25 quarters for the 'Large Banks' sub-sample and 22 out of 25 quarters for the 'Small Banks' sub-sample. I find that for the 'All Banks' model, maturity GAP is negatively related to the bank size. But this result is primarily driven by 'Small Banks' sub-sample. In the 'Large Banks' sub-sample, smaller banks manage their interest rate risk more. Larger banks, who are more likely to be the participants in the derivatives market, engage in lower levels of on-balance sheet risk-management.

Other results indicate that high growth banks maintain lower maturity GAP consistent with the theory of Froot et al. (1993). For the 'Large Banks' sub-sample, I find that derivative-hedgers maintain higher maturity GAP suggesting that these two methods of hedging act as substitutes. Since the 'Small Banks' sub-sample has a very few derivative users, in the subsequent analysis in the paper I focus exclusively on the 'Large Banks' sub-sample. My main results remain qualitatively similar for the 'All Banks' analysis.

In panel B of Table 6, I provide Fama-McBeth regression results for the derivatives activities of 'Large Bank' sample. In Panel B.1, I provide results for the yes-no decision of hedging by derivatives. Every quarter, I fit a logistic regression with decision to use derivatives for risk-management or not as dependent variable. The table reports the time-series means and Newey-West adjusted p-values of the cross-sectional estimates. Panel B.2 provides results for the extent of derivatives used by the user banks. Results from both these analyses (yes-no decision of derivative usage and the extent of hedging) indicate that banks with higher distress likelihood engage in higher hedging activities. I discuss the economic significance of these results later in the paper.

Consistent with prior empirical work, larger banks are more likely to engage in derivatives transactions. Banks with higher deposits use fewer derivatives. One possible explanation of this finding is the presence of subsidized FDIC insurance on the bank deposits, which creates a disincentive to manage risk. Consistent with Froot et al. (1993), high growth banks and banks with lower liquid assets engage in higher derivatives-hedging activities.

Overall, my results indicate that there is a greater inclination to manage the interest-rate risks (both by using derivatives and managing maturity GAP) when banks are faced with higher likelihood of financial distress. Smaller banks achieve this mainly by adopting a conservative maturity GAP policy, while larger banks make use of derivatives as well. The impact of firm growth and liquid assets on derivatives-hedging is significant and in the same direction as predicted by the hedging theories. However their impact on maturity GAP is not conclusive. Finally, maturity GAP decision and derivatives-hedging decisions act as substitutes for one another.

C. Simultaneous choice of maturity GAP and derivatives

The results presented so far assumes that banks make their maturity GAP and derivatives decisions separately, which may not be true in reality. In their case study of Banc One Corporation, Esty, Tufano and Headley (1994) state, '….in carrying out this mandate (mandate of interest rate risk-management) Banc One used investments (in securities) and derivatives as substitutes for one another.' Therefore, I model them as simultaneous choices using an instrumental variable approach. I instrument the derivatives-hedging decision by a bank's 'derivatives skill'. If a bank uses foreign currency, equity or commodity derivatives for trading or non-trading purposes then I assign a value of one to the 'derivative skill' instrument, zero otherwise. The choice of this instrument is motivated by the fact that a bank with derivatives position in other markets has all the necessary skills to engage in interest rate risk management using derivative instruments. The maturity GAP variable is instrumented with its own lag. The choice of lagged variable as an instrument is motivated by the assumption that frequent adjustments to maturity GAP is costly.

Every quarter I fit a simultaneous equation model with maturity GAP and derivatives decision as endogenous variables. For the maturity GAP model, in the first stage regression I use the yes-no decision to use derivatives as dependent variable and fit a logistic model to obtain the predicted likelihood of derivatives usages. The predicted derivatives usage likelihood is used as an explanatory variable in the second stage estimation with maturity GAP as dependent variable. Similarly, for the derivatives model, in the first stage estimation I fit an OLS model with maturity GAP as dependent variable and use the predicted value of GAP in the second stage estimation.

Table 7 provides the Fama-McBeth coefficient estimates and p-values of these models. First, note that the results of this model are qualitatively similar to the results of the earlier model without simultaneous estimation. Maturity GAP management and derivatives usage remain substitutes for one another. The key difference between the two models is the effect of growth variable on maturity GAP decision. In the simultaneous equation estimation, I find that high growth banks manage their risks more, both by means of maintaining lower GAP and by using more derivatives.

The effect of distress likelihood on hedging activities remains positive and significant as in the earlier model. As expected, there is positive and significant relation between 'derivative skill' dummy and the usage of interest rate derivatives for hedging. Other findings are similar to the earlier model.

D. Panel Data Estimation

I now estimate a panel regression with macroeconomic variables added to the model. To conserve space, I only provide results for the simultaneous estimation of maturity GAP and derivatives hedging decisions. As mentioned earlier, I present these results only for the large bank sample since small bank sample doesn't have enough number of derivatives users to allow me to draw statistically or economically meaningful conclusions. I estimate a bank fixed-effect model in simultaneous equation framework with 'lag GAP' and 'derivative skill' dummy as instruments as described earlier.

The results are provided in Table 8. Panel A provides the second stage estimation result for maturity GAP decision, while the Panel B provides the results for the extent of derivatives used by the user banks.[16] The firm level variables produce similar results in the panel regression as in the Fama-McBeth regression both in terms of the estimate value and their statistical significance. The probability of failure has a positive impact on hedging decisions. In economic terms, 1 percentage point increase in distress likelihood leads about 2-3% decrease in the bank's maturity GAP and about 15% increase in the extent of derivatives used by the banks.

The panel data estimation allows me to relate the hedging activities to macroeconomic shocks. I find that the levels of interest rates and term-spread positively influence the risk-management decisions via maturity GAP. A one percentage point increase in interest rates leads to about a quarter percentage point decrease in the bank's maturity GAP. Higher levels of interest rate correspond to a tighter monetary policy regime (see Bernanke and Blinder (1992)) and our results show that during such periods banks engage in higher risk-management activities via the on-balance sheet methods of hedging. When term-spread is high, funding long term assets with short term liabilities (and vice versa) can be costly. Thus the maturity GAP is less desirable under such scenario. I find evidence in support of this intuition. A one percentage point increase in term-spread leads to about 1/5 percentage decrease in the bank's maturity GAP. The effect of interest rate volatility and credit-spread is insignificant on the maturity GAP decision.

While the level of interest rates influences the maturity GAP decisions significantly, its impact on derivatives-hedging decision is insignificant. Banks do not significantly

[16] Since there are very few banks that initiate or terminate derivatives hedging decision during the sample period, I am unable to fit a panel data model for the yes-no decision of hedging.

change their derivatives hedging policy with the changing levels of the tightness of money supply. However, the effect of term-spread on derivatives is negative and significant. This result is a little counterintuitive as higher term-spread makes interest rate risk more costly. Instead of increasing their derivatives-hedging, banks reduce the level of derivatives when term-spread widens. To explore this further, I divide the sample of banks into positive (70% of banks) and negative (30% of banks) maturity GAPs. I find that the effect of term-spread is mostly concentrated in banks with negative GAPs. These banks significantly reduce their derivatives-hedges when term-spread is high, while banks with positive GAP do not exhibit a significant relation between term-spread and derivatives-hedging. The negative GAP firms have higher percentage of their long term assets financed by short term liabilities. When term-spread rises (i.e., the long term rates become relatively more attractive than the short term rates), these banks stand to benefit all else remaining equal. My finding suggests that under such scenario, negative GAP banks are taking a view on the interest rates by reducing their derivatives-hedging position (see Stulz (1996) for a discussion of firm's incentive to incorporate market-views in their risk-management program).

To summarize these findings, I find that the key firm level variables (financial distress cost, growth rate, liquidity, deposit financing and bank size) affect the on-balance sheet and derivatives hedging decision in a similar way. However, the market wide variables have differential impact on these two methods of hedging. While maturity-GAP management decisions are consistent with the risk-management incentives, the effect of macroeconomic shocks on derivatives-hedging is ambiguous. The tightness of money supply doesn't have a significant effect on derivatives-hedging, whereas the banks' response to changes in term-spread is more suggestive of a non-hedging (or market view) behavior. The overall credit quality in the economy and volatility in the underlying risk don't have meaningful impact on hedging decisions of the banks.

E. Users vs. non-users of Derivatives

I analyze the maturity GAP decisions of the users and non-users of derivatives separately to shed light on the on-balance sheet hedging decisions of these two groups. These results are presented in Table 9. The firm level variables provide qualitatively similar results; therefore I focus on the macro variables. The negative effect of interest rates on maturity GAP is concentrated in the sample of derivatives non-user banks only. When the money supply tightens, derivative non-users decrease their maturity GAP significantly, while the derivative users do not make changes to their GAP. Similarly, when term-spread widens, it's the non-user group that decreases its maturity GAP significantly; the user group again remains immune to this shock. These results suggest that the derivative users are able to maintain their asset-liability mix in the event of macro-shocks, whereas non-users make significant adjustments. In other words, the derivative non-users make significant changes to their operating policies to respond to the macroeconomic shocks. These changes can be achieved by offering different terms to their borrowers and depositors or making changes in other investment policies. Derivative instruments allow banks to maintain a stable operating policy, which presumably leads to a less volatile income stream. My results show that derivatives can smooth earnings not only by means of providing financial hedges, but also by allowing a more stable operating policy. Reduction in cash-flow and earning volatility can be desirable as evidenced by the findings of Minton and Schrand (1999) and Allayannis and Weston (2003). More research is needed to establish the role of derivatives on the operating policies of financial and non-financial firms.

F. Managerial Incentives of Hedging

Managerial incentives can have significant impact on a firm's hedging decisions. Consistent with the model of Stulz (1984), in a sample of 48 gold mining firms Tufano (1996) finds that the hedging incentives increase with managerial shareholdings, but decrease with their option-holdings. Schrand and Unal (1998) provide evidence that S&L's risk management activities after their conversion from mutual thrift to stock institution are related to their manager's compensation structure. Further studies (see for example, Graham and Rogers (2002), Knopf, Nam and Thorton (2002) and Geczy, Minton and Schrand (2003)) have used more sophisticated methods of computing managerial incentives by estimating the sensitivity of their wealth to stock prices changes (called the 'Delta') and stock return volatility (called the 'Vega') based on Black-Scholes-Merton model. Core and Guay (1999) provide a useful methodological approach to estimate these measures of managerial wealth sensitivity. Consistent with the theory of Stulz (1984), higher 'delta' provides higher risk-management incentives to the managers, whereas higher 'vega' leads to the opposite prediction.

The data on managerial compensation is obtained from the COMPUSTAT executive compensation database. This database only covers the publicly traded commercial banks. Thus the study involving managerial incentives is limited to only a small subset of my sample. Further, the data contained in the executive compensation database pertains to the publicly traded bank holding companies, and not the individual banks that I consider in the study. I use the compensation structure of these holding companies as a proxy for the managerial incentives of all banks with a given holding company.[17] Since the data on compensation is available only at annual intervals, I take the quarter corresponding to the fiscal year end for the accounting variables from the Call Report. The resulting sample comprises 1,275 bank-year observations with 472 observations belonging to the derivative users.

Following Core and Guay (1999), I construct the 'delta' and 'vega' for the top 5 managers of each bank in the sample. The median 'delta' and 'vega' for the sample firms are \$195,000 and \$49,680. These measures are added to the firm and market wide variables used in the earlier models. I report the panel data regression results for this model in Table 10. The firm level results remain qualitatively similar to the earlier results; however with lower p-values due to smaller sample size used in this study. I find that the banks with higher 'vega' maintain higher maturity GAP. This is consistent with

[17] In an alternative specification, I restrict my sample to only the largest bank within a holding company and the results remain qualitatively similar.

the findings of Tufano (1998). However, I don't find evidence in support of a positive relation between managerial 'delta' and risk-management activities as predicted by the existing theories of hedging based on managerial risk-aversion.

IV. Robustness

A. Loss Given Default Model

I use the predicted value of default likelihood as a measure of expected financial distress costs. This assumes that the losses in the event of default are equal for all banks. To ensure that my results are not driven by this assumption, I consider an alternative model where I generate an instrument for the 'expected loss in the event of default' rather than 'the probability of default'. To accomplish this task, in addition to the historical failure rates, I also need data on the losses incurred in each of these failures. Ideally, I need the information on deadweight losses such as legal and administrative expenses to estimate this model. Since exact estimates of these costs are not available, I use an alternative proxy which is based on the cost incurred by FDIC in resolving these failures. The data is obtained from the FDIC for all bank failures over my sample period (1980-2003). I estimate an OLS regression with cost to FDIC (scaled by the bank's asset in a quarter prior to failure) as the dependent variable and all exogenous variables (as in the estimation of the distress likelihood model) as independent variable. Results from this regression show that the losses of failure are higher for smaller banks, high growth banks, banks with higher level of non-deposit borrowings, higher non-performing assets, lower liquid assets and lower levels of loan asset. The losses are higher when overall credit quality in the economy is bad (i.e., higher credit-spread) and interest rates and term-spreads are lower.

Using the estimates from OLS model, I obtain a predicted value of 'losses in the event of default' for each bank-quarter observation and obtain the expected loss of default by the following formula:

Expected Loss of Default = Estimated Probability of Default (used in earlier analysis) x Estimated Loss in the event of default

I take the log of this variable as a proxy for financial distress costs and repeat my entire analysis using this new proxy. My results remain qualitatively similar. The parameter estimates and p-values on the distress cost variables (for the bank fixed effect panel regression model) are provided in Table 11.[18] Consistent with the distress cost theory, I find a negative (positive) and significant relation between the expected loss of default and maturity GAP (derivatives usage).

B. Demand Deposits as Non-Core Deposits

Demand deposits have unstated maturity. The median level of demand deposits in my sample banks is 11% of total assets and thus it can have significant effect on the computation of maturity GAP. Flannery and James (1984a) find evidence in support of the view that demand deposits are treated as 'sticky' i.e., as long term liabilities by the market. Esty et al. (1994) mention a similar view of demand deposits in their case study of Banc One. My analysis makes this assumption while computing the maturity GAP. However, as robustness I assume that 50% of the demand deposits are core deposits (and therefore long term liabilities), while the rest can be withdrawn in short term. With the new assumption, maturity GAP is computed again and I re-estimate the model with modified maturity GAP. My results remain robust. Table 11 provides the coefficients and p-values for the distress likelihood variable and confirms the findings of the earlier analysis. Other results are also similar to the case presented in the paper.

[18] To save space, I only report these estimates in the paper. The other results are similar to the model discussed earlier in the paper. These results and the estimation of loss given default model are available from the author upon request.

C. Maturity-Adjusted Derivatives

Consistent with the prior literature, I use the notional amount of derivatives as a proxy for the derivatives-hedging activities of a bank. A bank using $ 100 million of derivatives with 1-year maturity is considered to have similar level of hedging activity as another bank with a 5-year maturity contract of $100 million. This can be a reasonable assumption if the first bank in this example rolls over its hedge year after year. An alternative view is to adjust these instruments for their effective maturity and use the maturity-adjusted notional amount of derivatives as a proxy for the bank's derivative-hedging activities. Banks report the maturity of their derivative positions into three crude groups: interest rate derivatives with maturity of 1 year or less (item RCFD 3809 of the call report), maturity of 1 to 5 years (RCFD 8766) and the rest (RCFD 8767). Though it is not possible to construct an exact measure of the maturity-weighted derivatives position from this information, it allows considerable refinement over the un-weighted measure. To construct this measure, I consider the average maturity of 0.5 years for derivatives maturing within a year and 3 years for derivatives maturing within 1-5 years. I assume that all derivative instruments with greater than 5 year maturity have effectively similar effect on the firm's hedging policy and therefore I consider the maturity of 5 years for all such contracts. I multiply the notional amount of derivatives-hedging with average maturities to construct the maturity-weighted derivatives position of every bank and use this as a proxy for hedging activities. My results are robust to this adjustment as shown table 11.

D. Other Robustness Tests

The results of the study remain robust to the exclusion of top 25 banks from the sample. These banks are active dealers in the derivatives market and account for over 99% of dealing activities. The remaining derivative users engage in derivative transactions for their hedging needs only. Finally, my results remain robust to a separate estimation of the model for banks with assets of more than $500 million.

V. Concluding Remarks

In this study, I analyze the determinants of interest rate hedging in commercial banks. Interest rate risk has a significant impact on the banking sector and it provides a useful setting to test the theories of risk-management. Using a comprehensive measure of interest rate hedging that includes both on-balance sheet and off-balance sheet risk-management techniques, I find that the cost of financial distress provides higher hedging incentives to the banks. The on-balance sheet hedging activities act as substitutes to hedging by means of derivative instruments. Further, the derivative usage allows banks to maintain a steady level operating activities.

My findings have important implications for understanding the hedging behavior of firms as well as policy decisions regarding risk-management in the commercial banking sector. While the majority of current empirical work in the area uses derivative instruments as a hedging proxy, the comprehensive measure of hedging used in this study allows a more complete test of hedging theories. My finding that derivative and other means of hedging act as substitutes and not as complements suggests that we need to carefully interpret the results of empirical models using derivatives as only proxy for hedging. In this regard, my study provides large sample evidence in support of the two-firm case study of Petersen and Thiagarajan (2000).

This study suggests that a potential benefit of derivative usage comes from its ability to allow a firm to maintain smooth operating policies. The derivative user banks make less adjustments to their on-balance sheet maturity GAPs than the non-users. This means that the user banks need to adjust their lending, borrowing and investing policies much less than the non-user banks. This provides an additional channel by which derivative instruments can provide smooth cash-flows to the firm. Apart from generating cash in the adverse states of the world, derivative decisions can smooth cash-flows through its interaction with the operating decisions also. This finding is broadly consistent with the model of Froot et al. (1993) in which hedging allows firms to undertake optimal investment policies in future. More research is needed to assess the impact of derivatives on cash-flow smoothing and subsequently its value relevance for the banks.

My findings have policy implications for the role of risk-management in commercial banking. The fact that derivative users exhibit different reactions to macroeconomic shocks suggests that the presence of derivative contracts can change the impact of monetary policies on bank behavior. In view of the interaction of derivatives with the banks' operating policies, policymakers should consider the role of derivative instruments in setting monetary policies and evaluating their effects on the credit channels. Kashyap and Stein (1995, 2000) show that lending activities of large banks are less sensitive to the monetary policies than those of small banks. My findings suggest that the derivative usage can be a potential mechanism through which large banks are able to achieve this.

Appendix: Construction of Variables from Call-Report Data

Total Assets: Total Assets is taken from item RCFD2170.

Total Loans: Total Loans and Leases (Gross) are reported under item RCFD1400.

Derivatives Hedging: Till the fourth quarter of year 2000, derivatives used for non-trading purposes were reported under two items: derivatives that have been market to market and the others. For example, the interest rate derivatives used for non-trading purposes were reported under item number RCFD8725 for the portion that were marked to market and under RCFD8729 for the potion not marked to market. From the first quarter of 2001, the entire amount is being reported under RCFD8725. To form consistent time-series, I take the sum of RCFD8725 and RCFD8729 for the earlier period and RCFD8725 for the period starting from 2001Q1. Similarly for the currency, equity and commodity derivatives the consistent way to form the time series would be the following: RCFD8726+RCFD8730 (currency), RCFD8727+RCFD8731 (equity) and RCFD8728+RCFD8732 (commodity) for the earlier period and just RCFD8726, RCFD8727 and RCFD8728 respectively for the period starting from the first quarter of 2001.

Derivatives Used for Trading: I take the total notional values of derivatives used for trading by the banks reported under items RCFDA126 (interest rate), RCFDA127 (currency), RCFD8723 (equity) and RCFD8724 (commodity).

Net Income: RIAD4340

Maturity Gap: I construct a one year maturity-GAP as follows: (Loans and Leases due to mature and re-price within a year + Securities due to mature or re-price within a year + Fed Fund Sold + Customer's Liability to the Bank for Outstanding Acceptance) minus (Term Deposits due to mature or re-price within a year + Fed Funds Borrowed + Other Liabilities for Borrowed Funds + Bank's Liabilities on Customer's Outstanding Acceptance). I take the absolute value of this number and scale by the total assets of the bank to compute the one-year maturity gap ratio. Since the second quarter of 1997, the construction of GAP variable is relatively straightforward. Fixed rate loans and leases that mature within a year and floating rate loans that re-price within a year are constructed by summing RCONA570, RCONA571, RCONA564 and RCONA565. Debt securities that re-price (if floating) or mature (if fixed) within a year can be constructed by summing items RCONA549, RCONA550, RCONA555 and RCONA556. Term Deposits that matured or re-price within a year are obtained by summing RCONA579, RCONA580, RCONA584 and RCONA585. Fed Funds Sold and Borrowed come from RCFD1350 and RCFD2800 respectively. Other Liabilities for Borrowed money comes from RCFD2850. Customer's Liabilities to the Bank and Bank's Liabilities to the customers come from RCFD2155 and RCFD2920 respectively.

Non-Performing Assets (NPA): In line with Campello (2002), I use a measure of loan performance independent of the managerial discretion. I use loans over 90 days late (RCFD1407) plus loans not accruing (RCFD1403) scaled by total assets for this purpose.

Liquidity: I define the liquidity ratio as a sum of (Cash + Fed Funds Sold + Securities) scaled by the total assets of the bank outstanding at the end of the quarter. Cash is reported under RCFD0010. Fed Funds Sold comes from data item RCFD1360. To construct a consistent time-series, I define securities as the sum of two items: Total Investment Securities (RCFD0390) and Assets Held in Trading Account (RCFD2146) for quarters till 1993Q4. From the first quarter of 1994, it is defined as the sum of two items: Securities Held to Maturity (RCFD1754) and Securities Available for Sale (RCFD1773).

Total Equity: RCFD3210.

Demand Deposits: RCON2210.

Total Deposits: RCON2200.

Total Liabilities: RCFD2950.

References:

Allayannis, G. and J. Weston, 2001, "The Use of Foreign Currency Derivatives and Firm Market Value", Review of Financial Studies, 14, 243-276.

Allayannis, G. and J. Weston, 2003, "Earning Volatility, Cash Flow Volatility and Firm Value", Working Paper.

Altman E., 1968, "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcies", Journal of Finance, 23, 589-609.

Bernanke, B.S. and A.S.Blinder, 1992, The Federal Funds Rate and the Channels of Monetary Transmission, American Economic Review, 82, 901-921.

Buser, S., A. H. Chen and E. J. Kane, 1981, "Federal Deposit Insurance, Regulatory Policies and Optimal Bank Capital", Journal of Finance, 35, 51-60.

Booth ,J. R., R. L. Smith and R. W. Stolz, 1984, "The Use of Interest Rate Futures by Financial Institutions", Journal of Bank Research, 15, 15-20.

Breeden, D. and S. Viswanathan, 1996, "Why do Firms Hedge? An Asymmetric Information Model", Working Paper, Duke University.

Brewer, E., B.A.Minton and J.T.Moser, 2000, "Interest-Rate Derivatives and Bank Lending", Journal of Banking and Finance, 24,353-379.

Campello, M., 2002, "Internal Capital Markets in Financial Conglomerates: Evidence from Small Bank Responses to Monetary Policy", Journal of Finance, 57, 2773-2805.

Carter, D.A. and J.F.Sinkey, 1998, "The Use of Interest-Rate Derivatives by End-Users: The Case of Large Community Banks", Journal of Financial Services Research, 14,17-34.

Chava, S. and R. A. Jarrow, 2004, "Bankruptcy Prediction with Industry Effects", forthcoming Review of Finance.

Core J. and W. Guay, 1999, "The use of Equity Grants to Manage Optimal Equity Incentive Levels", Journal of Accounting and Economics 28, 151-184.

DeMarzo, P. M. and D. Duffie, 1991, "Corporate Financial Hedging with Proprietary Information", Journal of Economic Theory, 53,261-286.

Diamond, D. W., 1984, "Financial Intermediation and Delegated Monitoring," Review of Economic Studies, 51, 393-414.

Dolde, W., 1993, "The Trajectory of Corporate Financial Risk Management", Journal of Applied Corporate Finance, 6, 33-41.

Duffie, D., R.A. Jarrow, A. Purnanandam and W. Yang, 2002, "Market Pricing of Deposit Insurance", Journal of Financial Services Research, 24, 93-119.

Esty, B., P. Tufano and J. Headley, 1994, "Banc One Corporation: Asset and Liability Management", Journal of Applied Corporate Finance, 7, 33-51.

Flannery, M. J. and C. M. James, 1984a, "Marker Evidence on Effective Maturity of Bank Assets and Liabilities", Journal of Money Credit and Banking, 16, 435-445.

Flannery, M. J. and C. M. James, 1984b, "The Effect of Interest Rate Changes on the Common Stock Returns of Financial Institutions", Journal of Finance, 39, 1141-1153.

Froot, K. A., D. S. Scharfstein and J.C. Stein, 1993, "Risk Management: Coordinating Corporate Investments and Financing Policies", Journal of Finance, 5, 1629-1658.

Geczy, C., B. A. Minton and C. Schrand, 1997, "Why Firms Use Currency Derivatives?", Journal of Finance, 52, 1323-1354.

Geczy, C., B. A. Minton and C. Schrand, 2004, "Taking a View: Corporate Speculation, Governance and Compensation", Working Paper.

Gorton, G. and R. Rosen, 1995, "Banks and Derivatives", NBER Working Paper.

Graham, J. R. and D. A. Rogers, 2002, "Do Firms Hedge in Response to Tax Incentives", Journal of Finance, 57, 815-839.

Graham,J.R. and C.R.Smith, 1999,"Tax Incentives to Hedge",Journal of Finance,54, 2241-2262.

Guay W. and S. P. Kothari, 2003, "How much do Firms Hedge with Derivatives", Journal of Financial Economics, 70, 423-461.

Haushalter, D. G., 2000,"Financing Policy, Basis Risk, and Corporate Hedging: Evidence from Oil and Gas Producers", Journal of Finance, 55,107-152.

James, C., 1991, "The Losses Realized in Bank Failures", Journal of Finance, 46,1223-1242.

Kashyap, A.K. and J.C. Stein, 1995, The Impact of Monetary Policy on Bank Balance Sheet, Carnegie-Rochester Series on Public Policy, 42, 151-195.

Kashyap, A. K. and J. C. Stein, 2000, "What do a Million Observations of Banks Say About the Transmission of Monetary Policy?", American Economic Review, 90, 407-428.

Knopf J. D., J. Nam and J. H. Thornton, 2002, “The Volatility and Price Sensitivities of Managerial Stock Option Portfolios and Corporate Hedging”, Journal of Finance, 57, 801-813.

Leland, H. E., 1998, "Agency Costs, Risk Management, and Capital Structure", Journal of Finance, 53, 1213-1243.

Mayers, D. and C. Smith, 1982, "On the Corporate Demand for Insurance", Journal of Business, 55, 281-296.

Mian, S. L., 1996, "Evidence on Corporate Hedging Policies", Journal of Financial and Quantitative Analysis, 31, 419-439.

Minton B. A. and C. Schrand, 1999, “The impact of Cash-Flow Volatility on Discretionary Investment and the Costs of Debt and Equity Financing”, Journal of Financial Economics, 54, 423-460.

Nance, D. R., C. W. Smith and C. W. Smithson, 1993, "On the determinants of Corporate Hedging", Journal of Finance, 48, 267-284.

Ohlson, J., 1980, "Financial Ratios and the Probabilistic Prediction of Bankruptcies", Journal of Accounting Research, 19, 109-131.

Petersen, M. and S. R. Thiagarajan, 2000, “Risk Measurement and Hedging: With and Without Derivatives”, Financial Management, 29, 5-30.

Purnanandam, A., 2004, “Financial Distress and Corporate Risk-Management: Theory & Evidence”, Working Paper.

Schrand, C. M., 1997, “The Association between Stock-Price Interest Rate Sensitivity and Disclosures about Derivative Instruments”, The Accounting Review, 72, 87-109.

Schrand C. and H. Unal, 1998, “Hedging and Coordinated Risk Management: Evidence from Thrift Conversions”, Journal of Finance, 53, 979-1013.

Shumway, T., 2001, "Forecasting Bankruptcy More Accurately: A Simple Hazard Model", Journal of Business, January 2001, 101-124.

Smith, C. and R. Stulz, 1985, "The Determinants of Firms' Hedging Policies", Journal of Financial and Quantitative Analysis, 28, 391-405.

Stulz, R., 1984, "Optimal Hedging Policies", Journal of Financial and Quantitative Analysis", 19,127-140.

Stulz, R., 1996, "Rethinking Risk Management", Journal of Applied Corporate Finance,9, 8-24.

Tufano, P., 1996, "Who Manages Risk? An Empirical Examination of Risk Management Practices in the Gold Mining Industry", Journal of Finance, 51,1097-1137.

Table 1
Derivatives for Risk-Management Purposes
Summary Statistics

This table presents the descriptive statistics of the amount of interest rate and other derivatives used by commercial banks for risk-management purposes. The first two columns provide the total number of banks in the sample and the number of banks that used derivatives for risk management purposes as of the end of a calendar year. 'Outstanding – IR Derivatives' provides, in billions of dollars, the gross notional amount of outstanding derivatives contract used by the entire banking system for hedging purposes. "All derivatives" measures the gross notional value of interest rate, foreign exchange, equity and commodity derivatives used for the risk-management purposes. I also provide the gross notional value of derivatives used for risk-management purposes as reported in the quarterly bulletin of Office of Comptroller of Currency (OCC).

Quarter	Number of Banks	Users of IR Derivatives for Risk-Management Purposes		Outstanding - IR Derivatives ($ Billion)	Outstanding - All Derivatives ($ Billion)	IR Derivatives as a % of Total Derivatives	Derivatives OCC report ($ Billion)
		Number	% of Total				
1997Q4	9147	426	4.66%	1282.80	1509.31	84.99%	1500.00
1998Q4	8778	418	4.76%	1215.97	1411.04	86.18%	1400.00
1999Q4	8580	382	4.45%	1476.15	1580.44	93.40%	1600.00
2000Q4	8313	348	4.19%	1097.42	1211.78	90.56%	1200.00
2001Q4	8080	309	3.82%	1725.68	1774.63	97.24%	1800.00
2002Q4	7755	353	4.55%	2034.81	2094.40	97.15%	2100.00
2003Q3	7678	456	5.94%	2437.96	2494.65	97.73%	2500.00
Average	**8333**	**385**	**4.62%**	**1610.11**	**1725.18**	**92.47%**	**1728.57**

Table 2
Distribution of Derivatives End Users and Failed Banks by Size Quintiles

At the end of the fourth quarter of each year, I divide all banks in the sample into five groups based on their Total Assets in 2003 dollar terms. In Panel A, I provide the distribution of interest rate derivative users (for hedging purposes) across 5 size groups. 1 corresponds to the smallest group banks, 5 the largest. Panel B provides the distribution of failed banks across size-quintiles over different time-periods.

Panel A: Distribution of Derivative End Users Across Quintiles						
			Size Quintiles			
Quarter	**1**	**2**	**3**	**4**	**5**	**Total**
1997Q4	0	2	16	39	369	426
1998Q4	0	1	19	39	359	418
1999Q4	1	1	11	33	336	382
2000Q4	0	6	13	39	290	348
2001Q4	0	3	4	32	270	309
2002Q4	0	5	12	39	297	353
2003Q3	5	6	27	60	358	456
Average	**0.86**	**3.43**	**14.57**	**40.14**	**325.57**	**384.57**
%	**0.22%**	**0.89%**	**3.79%**	**10.44%**	**84.66%**	**100.00%**

Panel B: Distribution of Failed Banks Across Quintiles						
			Size Quintiles			
Period	**1**	**2**	**3**	**4**	**5**	**Total**
1980-84	47	49	34	20	26	176
1985-89	328	196	160	116	148	948
1990-94	132	95	62	62	69	420
1995-03	17	7	9	6	6	45
Total	**524**	**347**	**265**	**204**	**249**	**1589**
%	**32.98%**	**21.84%**	**16.68%**	**12.84%**	**15.67%**	**100.00%**

Table 3
Operating Characteristics of Users vs. Non-Users of IR Derivatives

This table presents the descriptive statistics of users and non-users of interest rate derivatives (for hedging purposes) based on a sample of 213,874 bank-quarter observations from the third quarter of 1997 to the third quarter of 2003 (on average 8368 observations per quarter). Out of this, there are 9,648 observations for the users of the interest rate derivatives. I provide the mean and median of the key operating characteristics of the two groups along with the p-values for the differences. The test for mean is based on a two sample t-statistics computed under the assumption of independence. The test for median is based on the standard Wilcoxson-Mann-Whitney statistics. All numbers are from the quarterly Call Report data.

	Derivative Users		Derivative Non-Users		Users minus Non-Users		p-value	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**	**Mean**	**Median**
Size ($ millions)	11985.88	1168.83	185.58	75.57	11800.30	1093.26	0.01	0.01
Total Deposit (% of total assets)	71.88%	75.53%	84.05%	86.19%	-12.18%	-10.66%	0.01	0.01
Demand Deposit (% of total assets)	9.95%	9.27%	12.48%	11.24%	-2.53%	-1.97%	0.01	0.01
Liquid Assets (% of total assets)	30.64%	29.05%	35.86%	33.92%	-5.22%	-4.88%	0.01	0.01
Loans & Leases (% of total assets)	63.90%	65.83%	60.86%	62.74%	3.05%	3.09%	0.01	0.01
Net Income (% of total assets)	0.85%	0.70%	6.03%	0.63%	-5.18%	0.06%	0.83	0.01
NPA (% of total assets)	0.64%	0.47%	0.64%	0.37%	-0.01%	0.10%	0.77	0.01
C&I Loans (% of total assets)	13.84%	12.01%	10.17%	8.47%	3.67%	3.54%	0.01	0.01
Quarterly Growth Rate	2.98%	2.39%	2.54%	1.75%	0.43%	0.65%	0.01	0.01
Total Equity (% of total assets)	9.53%	8.25%	10.83%	9.52%	-1.30%	-1.27%	0.01	0.01
Maturity Gap (% of total assets)	17.58%	13.38%	13.56%	10.64%	4.02%	2.74%	0.01	0.01

Table 4
First Stage Estimation of Distress Likelihood

This table presents the results of Logit Regression model for the estimation of distress likelihood using accounting data from the quarterly Call Reports and historical bank failure. The dependent variable is a binary variable that equals one for the quarter of failure and zero otherwise. I use all bank failures and Open Bank Assistances (OBAs) during the period 1980-2003 for which relevant data items could be obtained from the Call Reports. The model has been estimated for three groups: (a) All Banks (b) Small Banks (i.e., banks with less than $100 million in asset in 2003 dollar terms) and (c) Large Banks (assets more than $100 million). The number of observation used in each analysis is provided at the bottom of the table. The explanatory variables are as follows: Size represents the log of Total Assets of the bank; NI measures Net Income; TD stands for total deposit; NDL stands for non-deposit liabilities; NPA for Non-Performing Assets; Loan for the gross amount of loans and leases; Liquid for cash and liquid assets. All these variables (except size) have been scaled by the total assets of the bank as of the end of the given quarter. Growth measures the average quarterly growth rate in total assets over the past four quarters. IR Level represents the average interest rate (3 months T-Bills) during the quarter; IR Volatility measures the standard deviation of daily interest rates within the quarter; Term-spread is the average yield difference between 10 year and 1 year Treasury Bond in the quarter; Credit-spread measures the yield difference between a BAA and AAA corporate debt.

Variable	**All Banks**		**Small Banks**		**Large Banks**	
	Estimate	**p-value**	**Estimate**	**p-value**	**Estimate**	**p-value**
Intercept	-28.7649	0.01	-28.7466	0.01	-28.3164	0.01
Size	-0.1355	0.01	-0.5629	0.01	0.0225	0.75
NI/TA	0.0005	0.78	0.0010	0.68	-7.8501	0.01
TD/TA	33.6763	0.01	38.1967	0.01	29.8816	0.01
NDL/TA	10.9762	0.01	6.8357	0.01	24.2766	0.01
NPA/TA	16.6648	0.01	15.0465	0.01	18.7071	0.01
Loan/TA	-8.6559	0.01	-8.2343	0.01	-8.5508	0.01
Liquid/TA	-10.4367	0.01	-11.5059	0.01	-6.7335	0.01
Growth Rate	-12.8686	0.01	-10.0274	0.01	-13.5333	0.01
IR Level	0.1932	0.01	0.2375	0.01	0.1087	0.04
IR Volatility	-0.4888	0.05	-0.9536	0.01	0.0573	0.90
Termspread	0.3047	0.01	0.3795	0.01	0.3196	0.01
Creditspread	-0.0623	0.69	-0.1414	0.45	-0.3276	0.25
# of Failures	1443		1064		379	
Total # of obs	853469		513836		339633	
% Concordant	90.20%		94.00%		87.50%	
Gamma Statistics	97.90%		98.20%		98.30%	

Table 5
Out-of Sample Predictive Power of the Distress Model

This table provides the result of out-of sample predictive power of the distress likelihood model. At the beginning of each year, I fit the distress logistic model using bank-quarter observations available till the end of the previous year. Based on these ex-ante parameter estimates and accounting data as of the latest Call Report of the previous year, the failure likelihood is estimated for all surviving banks at the beginning of the year. Banks are sorted into deciles based on fitted probability values. I report the percentage of banks that failed in the following year across various deciles of fitted values. 1 stands for the highest likelihood of failure and 10 for the lowest as per the fitted probability values. The table also reports the model predicted median failure rate (in terms of % probability of failure per year) for the aggregate sample of banks and the banks that failed during the year.

Year	Median Failure Rate (%.) - All Banks	Median Failure Rate (%.) - Failed Banks	Number of Failed Banks	Distribution of Failed Banks in Failure-Probability Deciles				
				1	2	3	4	5-10
1990	0.27	19.51	152	148	0	0	2	2
1991	0.21	12.97	103	99	0	1	1	2
1992	0.23	18.01	94	79	8	3	1	3
1993	0.23	15.25	39	37	0	0	0	2
1994	0.15	11.84	11	10	0	0	0	1
1995	0.11	13.39	6	5	0	0	0	1
1996	0.08	9.00	5	4	0	0	0	1
1997	0.08	0.08	1	0	0	0	0	1
1998	0.06	0.14	3	1	1	0	0	1
1999	0.03	1.83	7	5	0	0	0	2
2000	0.06	0.08	5	2	0	0	1	2
2001	0.04	0.07	3	1	0	1	0	1
2002	0.04	0.16	8	3	1	1	0	3
2003	0.03	2.62	2	1	0	0	0	1
Aggregate	**0.12**	**7.50**	**439**	**395**	**10**	**6**	**5**	**23**
% of total				**89.98%**	**2.28%**	**1.37%**	**1.14%**	**5.24%**

Table 6
Risk Management Decisions : Fama McBeth Regression

This table provides the results of Fama McBeth regressions. In Panel A, first I estimate a cross sectional regression every quarter with maturity GAP as dependent variable and the firm characteristics as independent variables. In this table I report the time-series mean of the parameter estimates and the corresponding p-values. The p-values are corrected for autocorrelation of 4 lags and heteroskedasticity using the methods suggested by Newey-West. PD stands for the probability of default and is computed in the first stage distress likelihood model. Size measures the log of total assets of the bank. TD/TA refers to total deposits as a ratio of total assets. Growth is computed as the average quarterly growth over last four quarters. Liquid measures the extent of liquid assets held by the bank scaled by its total assets. Derivatives Dummy equals 1 if the bank has used interest rate derivatives for hedging purposes, zero otherwise. I report results for three models: (a) 'All Banks' that uses all observations; (b) 'Small Banks' for banks with assets less than \$100 million and (c) 'Large Banks' for banks with assets greater than \$100 million. In Panel B.1, I report the results from the 'yes-no' decision of derivative-hedging for the sample of 'Large Banks'. A logistic regression is estimated every quarter using the Derivatives Dummy as the dependent variable and the table presents the time-series mean and p-value of these cross-sectional estimates. In Panel B.2, I take the extent of derivatives used by the user banks as the dependent variable.

Panel A: Dependent Variable - 12-month Maturity Gap

	All Bank		Small Banks		Large Banks	
	Estimate	p-value	Estimate	p-value	Estimate	p-Value
Intercept	-0.2412	0.11	-0.2143	0.43	-0.0249	0.78
PD	-0.0218	0.01	-0.0232	0.02	-0.0154	0.01
Size	-0.0019	0.07	-0.0245	0.01	0.0083	0.01
TD/TA	0.3694	0.02	0.5961	0.08	-0.0047	0.94
Growth	-0.1330	0.05	-0.0741	0.45	-0.0121	0.79
Liquid	-0.0556	0.02	-0.0773	0.12	-0.0110	0.46
Derivatives Dummy	0.0263	0.01	-0.0138	0.16	0.0162	0.01

Panel B: Derivatives for risk-management purposes (Large Bank Sample)

	B.1: Yes-No Decision		B.2: Extent of Derivatives Usage	
Intercept	-13.2100	0.01	-2.8840	0.01
PD	0.1957	0.01	0.0558	0.04
Size	1.1175	0.01	0.0988	0.01
TD/TA	-3.3460	0.01	-1.7080	0.01
Growth	1.7004	0.21	1.9383	0.02
Liquid	-0.7042	0.01	-1.4350	0.01
Maturity Gap	0.6543	0.01	1.7394	0.01

Table 7
Simultaneous Choice of Maturity Gap and Derivatives Position

This table provides the results from Fama-McBeth regressions for simultaneous estimation of on and off-balance sheet risk management decisions of the banks. The maturity GAP decision and the decision to use derivatives or not are taken as endogenous variables. I instrument maturity GAP with its own lag and the derivatives usage decision by a bank's 'derivatives skill' and adopt a two-stage methodology to estimate the model. The estimation is carried every quarter from 1997Q4 to 2003Q3. This table provides the time-series mean and p-value for the cross-sectional parameter estimates. All estimations use Newey-West heteroskedasticity- and autocorrelation-consistent errors. Panel A provides the results for Maturity GAP decision. Panel B provides the estimation results for decision to use derivatives (for risk-management purposes) or not. Finally Panel C provides results on the extent of derivatives used by the derivative users. 'Skill' is a dummy variable that equals 1 if a bank uses other derivatives (foreign currency, commodity or equity) for trading or non-trading purposes. 'Derivatives-Est' is the estimated probability (from first stage regression) of derivatives usage by a bank. 'GAP-Est' is the estimated maturity GAP from the first stage regression.

	Panel A: Maturity Gap Decision		**Panel B: Yes-No Decision to use Derivatives**		**Panel C: Extent of Derivatives for the User Sample**	
Variable	**Estimate**	**p-value**	**Estimate**	**p-value**	**Estimate**	**p-value**
Intercept	-0.0287	0.11	-12.1300	0.01	-1.6630	0.01
PD	-0.0026	0.01	0.1882	0.01	0.0594	0.02
Size	0.0011	0.04	1.0353	0.01	0.0178	0.10
TD/TA	0.0203	0.15	-3.3480	0.01	-1.8100	0.01
Growth	-0.0274	0.06	1.8097	0.23	1.9670	0.02
Liquid/TA	0.0015	0.72	-0.9652	0.01	-1.7180	0.01
Lag GAP	0.9087	0.01				
Skill			1.1512	0.01	0.5233	0.01
Derivatives-Est	0.0050	0.03				
GAP-Est			0.4734	0.06	1.6680	0.01

Table 8
Fixed-Effect Panel Regressions

This table provides the result from a fixed effect panel regression with simultaneous estimation of maturity GAP and derivatives usage decision. Panel A and B provide the result for maturity GAP and extent of derivative usage decisions respectively. Maturity GAP model is estimated using 88,397 observations over 1997Q4 to 2003Q3. Derivatives model is estimated using the sample of 8,439 derivative users over the same time-period. I provide the parameter estimates and p-values from the second stage regression. IR Level refers to the average interest rate (3-month Treasury) during the quarter. IR Volatility measures the standard deviation of the same interest rate series during the quarter. Term-Spread is the yield difference between 10 and 1 year Treasury. Credit Spread measures the yield difference between a BAA and a AAA corporate borrower.

	Panel A: Maturity GAP Decision		**Panel B: Extent of Derivatives Used**	
Variables	**Estimate**	**p-value**	**Estimate**	**p-value**
Intercept	-0.0162	0.01	-1.3072	0.01
PD	-0.0026	0.01	0.0621	0.01
Size	0.0009	0.01	0.0137	0.28
TD/TA	0.0211	0.01	-1.7356	0.01
Growth	-0.0258	0.01	1.7258	0.01
Liquid/TA	0.0004	0.76	-1.7000	0.01
Lag GAP	0.9094	0.01		
Skill			0.5630	0.01
Derivatives-Est	0.0064	0.01		
GAP-Est			1.6313	0.01
IR Level	-0.0023	0.01	-0.0618	0.14
IR Volatility	0.0010	0.59	-0.0049	0.98
Termspread	-0.0018	0.01	-0.1422	0.01
Creditspread	-0.0009	0.50	0.0568	0.67
R-squared	83.56%		11.68%	

Table 9
Maturity Gap Decision Across Derivative Users and Non-Users

This table provides the result from a fixed effect panel regression model for the maturity GAP decisions of two groups of the banks: (a) users of derivatives (for risk-management purposes) and (b) non-users of derivatives. Panel A (users) is estimated with 8,439 observations while Panel B uses 79,958 observations. The model is estimated in two stages. In the first stage, I obtain the likelihood of derivatives usage using 'Derivative Skill' as an instrument. In the second stage, I regress the Maturity GAP variable on the predicted value of derivatives usage (Derivatives – Est) along with other independent variables. I provide the parameter estimates and p-value from the second stage estimation in this table.

	Panel A: Derivative Users		**Panel B: Derivative Non-Users**	
Variables	**Estimate**	**p-value**	**Estimate**	**p-value**
Intercept	-0.0690	0.01	-0.0066	0.29
PD	-0.0041	0.01	-0.0024	0.01
Size	0.0028	0.01	0.0003	0.44
TD/TA	0.0279	0.01	0.0207	0.01
Growth	-0.0497	0.01	-0.0203	0.01
Liquid/TA	0.0026	0.55	0.0006	0.63
Lag GAP	0.9248	0.01	0.9062	0.01
Derivatives-Est	-0.0062	0.32	0.0113	0.01
IR Level	0.0002	0.92	-0.0025	0.01
IR Volatility	-0.0106	0.13	0.0022	0.25
Termspread	-0.0001	0.98	-0.0019	0.01
Creditspread	0.0073	0.15	-0.0015	0.27
R-squared	86.53%		82.82%	

Table 10
Managerial Incentives of Risk-Management

In this table, I report the estimation results for maturity GAP and derivatives decisions for a smaller sub-sample of banks with data on executive compensation available on COMPUSTAT EXECCOMP database. Panel A provides the results of a fixed effect model with banks' maturity GAP as dependent variable. Panel B provides results for the extent of derivatives used. 'Delta' and 'Vega' measure the sensitivity of the bank's top 5 managers' wealth to stock prices and return volatility respectively. These measures are estimated using the Black-Scholes-Merton model of option valuation for dividend paying stocks following the methodology suggested by Core and Guay (1999). Panel A is estimated using 1275 observations, while Panel B uses 472 observations.

	Panel A: Maturity GAP Decision		**Panel B: Extent of Derivatives Used**	
Variables	**Estimate**	**p-value**	**Estimate**	**p-value**
Intercept	0.0292	0.57	-0.8950	0.70
PD	-0.0028	0.06	0.2221	0.03
Size	-0.0043	0.23	0.2453	0.00
TD/TA	-0.0078	0.65	-1.8162	0.02
Growth	0.1244	0.01	0.9769	0.65
Liquid/TA	0.0129	0.35	-4.5577	0.01
Lag GAP	0.8937	0.01		
Skill			0.4007	0.03
Derivatives-Est	0.0183	0.36		
GAP-Est			2.7126	0.01
IR Level	0.0018	0.80	-0.3087	0.22
IR Volatility	0.0310	0.77	-7.1517	0.08
Termspread	0.0120	0.07	-0.5641	0.01
Creditspread	-0.0187	0.58	1.6567	0.20
Delta	0.0025	0.28	-0.2109	0.03
Vega	0.0037	0.09	-0.0398	0.68
R-squared	83.91%		29.54%	

Table 11
Robustness Table

This table provides three robustness results. In the first model, instead of using the probability of default as an explanatory variable, I use the expected loss in the event of default as a proxy for financial distress cost. First I estimate a loss-given-default model based on actual losses experienced by FDIC in bank failures. Based on these estimates and the probability of failure, I construct an instrument for the expected loss of distress (=estimated probability of distress x estimated loss in the event of distress). In the second model, I consider 50% of demand deposits as non-core deposits, i.e., these deposits are treated as short term liabilities for the purpose of computing maturity GAP. Finally in the third model, I compute a maturity weighted average of firm's derivatives position and use this measure as a proxy for the extent of hedging by means of derivatives. For each of these models, I provide the coefficient on default likelihood variable (expected loss variable for the first model) for a bank fixed effect regression model. In Panel A, the maturity GAP is the dependent variable, while in Panel B, the log of the IR derivatives scaled by the total assets of the firm has been used as the dependent variable.

Models	Panel A: Maturity GAP	Panel B: Extent of Derivatives
Loss Given Default Model	-0.0037	0.2477
	(0.01)	(0.01)
50% of DD as *non-core*	-0.0021	0.0490
	(0.01)	(0.01)
Maturity-Adjusted Derivatives	-0.0019	0.0372
	(0.01)	(0.01)